COMPARISON OF THE EFFECTS OF CORE EXERCISE AND BALANCE STRATEGY EXERCISE ON WALKING SPEED AND FRAILTY LEVEL IN THE ELDERLY

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ABSTRAK

Penuaan menyebabkan perubahan fisiologis dan biomekanik, termasuk penurunan otot, berkurangnya panjang langkah, kecepatan berjalan lebih lambat, dan peningkatan risiko jatuh. Studi ini membandingkan efek latihan inti dan keseimbangan pada kecepatan berjalan dan tingkat kelemahan pada orang tua. Ini menggunakan Desain Kelompok Kontrol Pra dan Pasca Tes dengan 40 responden yang dibagi secara acak menjadi dua kelompok. Satu kelompok melakukan latihan inti, sementara yang lain berlatih latihan strategi keseimbangan, keduanya dilakukan tiga kali seminggu selama empat minggu. Kecepatan berjalan diukur menggunakan tes kecepatan berjalan 4 meter, dan kelemahan dinilai dengan Indeks Kelemahan. Hasil penelitian menunjukkan bahwa pada kelompok inti, kecepatan berjalan pasca-tes rata-rata 1,27 m/s, meningkat dari 0,98 m/s (p=0,00), sedangkan pada kelompok keseimbangan, meningkat dari 1,03 m/s menjadi 1,14 m/s (p=0,004). Skor Indeks Kelemahan kelompok inti menurun dari 1,55 menjadi 0,6 (p=0,00), sedangkan skor kelompok keseimbangan menurun dari 1,6 menjadi 1,4 (p=0,046). Tidak ditemukan perbedaan signifikan antara kelompok dalam peningkatan kecepatan berjalan (p=0,051), tetapi latihan inti secara signifikan mengurangi kelemahan lebih banyak daripada latihan keseimbangan (p=0,00). Sebagai kesimpulan, kedua jenis latihan tersebut meningkatkan kecepatan berjalan dan mengurangi kelemahan pada lansia. Namun, meskipun latihan inti dan latihan keseimbangan memiliki efek yang sama pada kecepatan berjalan, latihan inti secara signifikan lebih efektif dalam menurunkan tingkat kelemahan.

Kata kunci : kecepatan berjalan, latihan inti, latihan strategi keseimbangan, tingkat kelemahan

ABSTRACT

Aging leads to physiological and biomechanical changes, including muscle decline, reduced stride length, slower walking speed, and increased fall risk. This study compares the effects of core and balance training on walking speed and frailty levels in the elderly. It used a Pre and Post Test Control Group Design with 40 respondents randomly divided into two groups. One group performed core exercises, while the other practiced balance strategy exercises, both conducted three times a week for four weeks. Walking speed was measured using the 4-meter gait speed test, and frailty was assessed with the Frailty Index. Results showed that in the core group, the post-test walking speed averaged 1.27 m/s, improving from 0.98 m/s (p=0.00), while in the balance group, it increased from 1.03 m/s to 1.14 m/s (p=0.004). The core group's Frailty Index score decreased from 1.55 to 0.6 (p=0.00), while the balance group's score reduced from 1.6 to 1.4 (p=0.046). No significant difference was found between groups in walking speed improvement (p=0.051), but core exercise significantly reduced frailty more than balance training (p=0.00). In conclusion, both training types improved walking speed and reduced frailty in the elderly. However, while core exercise and balance training had similar effects on walking speed, core exercises were significantly more effective in lowering frailty levels.

Keywords *: balance strategy exercise, core exercise, frailty level, walking speed*

INTRODUCTION

Geriatric physiotherapy is a branch of physiotherapy science that focuses on elderly health care. The goal is to increase mobility, minimize pain, and improve the quality of life of the elderly. Geriatric physiotherapy focuses on restoring body functions that are decreasing due to aging or certain health conditions (Wibawa et al., 2017). According to Law no. 13 of 1998

concerning Elderly Welfare, states that an elderly person is someone who has reached the age of 60 years (sixty) and above (Dinkes , 1998). According to the World Health Organization (WHO), the proportion of people over 60 years of age in the world from 2000 to 2050 will double from about 11% to 22%, or in absolute terms increase from 605 million to 2 billion elderly (WHO, 2020). The Central Bureau of Statistics noted that in 2015 in Indonesia the number of people aged > 60 years was 8.49% and is predicted to increase to 15.77% by 2035 (Suryamin, 2015).

Elderly people are closely related to geriatric syndrome, one of which is frailty (Mehrlatifan et al., 2023).Frailty is a geriatric syndrome defined by a reduced capacity to recover from health stressors due to reduced endurance strength, and physiological power. Approximately 10% of people over the age of 65 and 25% to 50% of those aged 85 years experience frailty, according to criteria established by Fried (Siallagan & Gessal, 2021). The overall prevalence of frailty in community-dwelling older adults aged 65 or older in the United States ranges from 7-12%, in 10 European countries the prevalence of frailty ranges from 5.8% in Switzerland to 27% in Spain with an overall prevalence of 17% (O'Caoimh et al., 2021). In Indonesia the prevalence of frailty is 26.8%, 37.9% in nursing homes, 26.3% in hospitals, and 21.1% in community settings. Various studies have shown the impact of frailty on the incidence of falls, worsening of disability and mortality (Pradana et al., 2023).

Aging is accompanied by many changes in physiological and biomechanical factors, such as damage and decline in muscle function, reduced stride length and walking speed, reduced ability to maintain balance, and increased risk of falls and stumbles (Mehrlatifan et al., 2023). In research conducted in the field of dynamic balance of the elderly, it has been shown that human physical abilities tend to decline with age, and the factor causing this decline is a decrease in muscle strength. This decline is mainly due to the loss of muscle fibers and cross-sectional area. Muscle weakness in the thigh abductor, knee flexor, and ankle dorsiflexor muscles is associated with the risk of falling while moving and walking (Kamaledin ---Mousavi & Sadeghi, 2013).A person will experience faster loss of muscle mass at the age of 60-70 years. The rate of muscle mass loss varies from person to person. In each decade, muscle mass will be lost by 3-8%. This loss of mobility is greater in the lower extremities than the upper extremities (Papalia et al., 2020).

As a basic locomotion skill, walking occupies the largest share of daily human movement activities. This skill, which is associated with old age issues, is considered an indicator of the degree of independence in performing daily tasks in the elderly. Lack of control and balance when walking in the elderly is potentially a major cause of falls. Research shows that elderly people who fall have lower walking performance and show less physical activity than people who do not fall. The experience of falling creates a fear of walking and ultimately leads to social isolation and decreased quality of life (McCormick & Vasilaki, 2018). Core exercise is a comprehensive exercise program, which addresses every sub-system of movement, it can significantly improve postural alignment, strength production, standing endurance, overall mobility, and reduce the risk of falls in the elderly (Sadaqa et al., 2023). Core exercise is aimed at the core muscles, namely the abdominal and lumbopelvic muscles. Strong core muscles can improve balance and stability (Fatimah S et al., 2022).

Balance strategy exercise is a series of movements performed with the aim of improving both static and dynamic balance (Shah & Varghese, 2014). Based on this, researchers want to analyze the effectiveness of core exercise and balance strategy exercise on walking speed and frailty index in the elderly.

METHODS

This experimental study employed a *Pre and Post Test Control Group Design* and was conducted at the Potroyudan Elderly Service Centre in Jepara, Central Java. The study

population consisted of 57 individuals, with 40 participants selected through *purposive sampling* after passing the preliminary research stage using the RAPUH questionnaire and meeting the inclusion criteria. Participants were randomly assigned to two groups: one performing core exercises and the other engaging in balance strategy exercises. Walking speed was measured using the *4-meter gait speed test*, in which respondents walked on a flat surface over a total distance of 9 meters, with the middle 4 meters recorded. The test was conducted twice, and the fastest recorded time was used as the final result. Frailty levels were assessed using the *Frailty Index*, which evaluates five key components: fatigue, resistance, ambulation, illness, and weight loss.

Balance Strategy Exercises encompassed ankle, hip, and stepping strategies. The ankle strategy involved shifting body weight in various directions—forward, backward, right, and left—while maintaining balance for 8 counts, repeated three times. The hip strategy focused on controlled hip movements while keeping an upright posture, also held for 8 counts and repeated three times. Meanwhile, the stepping strategy required participants to step forward and backward alternately while sustaining balance, performed in three repetitions. These exercises were designed to enhance postural control, improve stability, and mitigate frailty. Through consistent practice, participants were expected to develop better coordination and overall mobility.

Core exercises were designed to strengthen the body's core muscles and consisted of quadruped movements, floor exercises, and the dead bug exercise. In the quadruped movement, participants alternately lifted opposite limbs while maintaining balance for 8 counts, repeated for 12 repetitions. Floor exercises included hip lifts, ensuring proper alignment of the hips, shoulders, and knees, also performed for 12 repetitions. The dead bug exercise involved coordinated arm and leg movements while keeping the core engaged, with the same repetition count. These exercises aimed to enhance core stability, improve postural control, and support overall mobility. After four weeks of intervention, both groups underwent a post-test evaluation using the *4-meter gait speed test* and *Frailty Index* to assess improvements in walking speed and reductions in frailty. The results were expected to demonstrate the effectiveness of core exercises in promoting better balance and reducing the risk of falls among elderly individuals.

RESULT

Table 1. Characteristics of Research Subjects

Characteristics	Core (n=20)	Balance (n=20)	P
Gender			1,000*
Male	6 (30%)	6 (30%)	
Female	14 (70%)	14 (70%)	
Age			0,413*
60 Year	4 (20%)	4 (20%)	
61 Year	1 (5%)	2 (10%)	
62 Year	4 (20%)	3 (15%)	
63 Year	2 (10%)	1 (5%)	
64 Year	3 (15%)	2 (10%)	
65 Year	1 (5%)	1 (5%)	
66 Year	2 (10%)	2 (10%)	
67 Year	0	1 (5%)	
68 Year	1 (5%)	1 (5%)	
69 Year	1 (5%)	2 (10%)	
70 Year	1 (5%)	1 (5%)	
BMI Mean ± SD	23,53±4,86	23,15±5,36	0,584*
Nutrition Status Mean ± SD	25,64± 1.99	25,99±1,50	0,084*

Table 2. Test Results of The Effect of Core Exercise and Balance Strategy Exercise

Group	*Core*	P	*Balance*	P		
	Pre	**Post**		**Pre**	**Post**	
4MGST	0,98	1,27	0,000*	1,03	1,14	0,004*
FI	1,55	0,6	0,000*	1,6	1,4	0,046**

*paired sample t test paired sample t test, **wilcoxon

Table 3. The Results of The Difference Test of The Difference Between Core Exercise and Balance Strategy Exercise

Test	*Core*	*Balance*	P
Mean 4MGST	0,285	0,105	0,051*
Mean FI	0,58	1,50	0,000**

* Independent T Test, ** Mann-Whitney U

Table 1 shows that most of the research subjects were female with a percentage of 70% and 30% were male in both the core and balance groups. The distribution of age groups between core and balance groups is relatively similar with a value of (p = 1.000). The characteristics of the research subjects based on age showed that the core group was more at the age of 60 and 62 years with a percentage of 40% each, while the balance group showed more subjects at the age of 60 years with a percentage of 40%. The distribution of age groups between the core and balance groups is relatively similar with a value of (p=0.413). Characteristics of research subjects based on body mass index showed that the core group had an average value of 23.53 while for balance 23.15 with a value of (p=0.584). The characteristics of the research subjects based on nutritional value status showed that the core group had an average value of 25.64 while for balance 25.99 with a value of (p=0.084). Based on table 1, it can be stated that the characteristics of the research subjects between the core and balance groups are homogeneous.

Table 2 shows the effect test on the 4MGST measurement parameters using a paired sample t test with the results showing that there is an increase in walking speed in the elderly between groups. The average post-test in the core group was faster with a time of 1.27 m/s compared to the pre-test with an average time value of 0.98 m/s. In the balance group, the average post-test time of 1.14 m/s was faster than the pre-test with an average time of 1.03 m/s. The effect test on the Frailty Index measurement parameters using nonparametric tests with the results showed a decrease in the Frailty Index score in the elderly between groups shown in graph 4.2. The Frailty Index score in the core group with an average posttest of 0.6 is lower than the pretest of 1.55. While in the balance group the average Frailty Index score of 1.4 was lower than the pretest with an average score of 1.6.

Table 3 show the test of different effects using independent sample t test on the measurement parameters of the 4 meter gait speed test with p value> 0.05 which shows that there is no significant difference between core exercise and balance strategy exercise. While on the measurement parameters of the Frailty Index, the test of different effects using nonparametric tests with a p value <0.05 shows that there is a significant difference between core exercise and balance strategy exercise.

DISCUSSION

Characteristics of Research Subjects

The most age is in the age range of 60 - 65 years with a total of 15 people in the Core Exercise group. While in the Balance Strategy Exercise group as many as 13 people. The age range of respondents in this study was in the elderly category, the increasing age in the elderly will progressively decrease in body functionality, muscle strength and decreased balance. This

can increase the risk of falls in the elderly. Several previous studies have mentioned that the age of 80 years and over has experienced a much greater decline in physical condition than the age range below, and is also followed by cognitive impairment, so it does not meet the criteria to be a sample of this study. This study is in line with previous research which states that the elderly who have entered the age of 80 years and over will experience a very significant aging process. The ability of tissues to regenerate and maintain normal structure and function will slowly decline, so that elderly people of this age are no longer able to withstand injury and repair the damage suffered (Espejo-Antúnez et al., 2020).

Sample characteristics in terms of gender showed that the core exercise group was dominated by elderly women as many as 14 people (70%) and in the balance strategy exercise group also dominated by elderly women as many as 14 people (70%). The results of this study are in line with research conducted by (Espejo-Antúnez et al., 2020). Elderly men have better body functionality than women, influenced by higher levels of physical activity. In addition, women in general when entering the age of 45 - 50 years will experience menopause. These hormonal factors contribute to the onset of a number of physical changes, due to a decrease in the hormone estrogen which causes bones to lose calcium, affecting balance. Therefore, women tend to experience faster musculoskeletal decline than men, which is around 25-30% (Khaerah, 2021).

Based on the BMI of each group, the average result for the core group is 23.53 with a standard deviation of 4.86, then for the balance group the average result is 23.15 with a standard deviation of 5.36 from the two groups it can be concluded that the BMI value is still within the normal value, notaga. Someone who has a normal BMI tends to have a better static balance value than someone who does not have a normal BMI. The body's balance function involves the activity of muscle strength and the accumulation of adipose tissue (Melinda, 2019). An increase in body mass index will affect muscle strength, so if the muscles are weak and body mass increases, there will be problems with body balance when standing or walking. Low muscle mass can lead to biomechanical failure of muscle response and loss of body balance mechanism. A person with less than normal BMI tends to have lower balance because the ability to resist the influence of external forces is lower, making it more difficult to maintain balance (Redha et al., 2022).

The results of the analysis of respondents based on the nutritional status of each group obtained the average results for the core group 25.64 with a standard deviation of 1.99 then for the balance group the average results were 25.99 with a standard deviation of 1.50 from both groups it can be concluded that the nutritional status of the elderly who were research respondents was still within normal values. Nutritional status is one of the factors that affect the quality of life of the elderly. Nutrition plays a role in the aging process, improving health status and creating healthy aging in the elderly. Undernutrition causes progressive weight loss and muscle mass, the risk of osteoporosis, fractures, functional, psychological disorders and the risk of morbidity, while overnutrition causes inflammation, increases the risk of morbidity and is closely related to body pain in the elderly (Hikmah & Pradana, 2022).

The Effect of Core Exercise on Walking Speed

The results of data analysis in tables 4.2 and 4.3 show changes in pre-test and post-test values after giving core exercise. To measure walking speed, the 4MGST parameter is used, the pre-test and post-test results show an increase in the mean value (0.98 m/s - 1.27 m/s) which means that there is an increase in walking speed in the elderly through 4MGST measurements. Researchers assume that the increase in the mean value in the intervention group is due to the core exercise given. The increase in walking speed in the elderly is due to increased strength of the back muscles and leg muscles after being given core exercise. This assumption is reinforced by research which states that strong back muscles and leg muscles will bond kinetic

chains that cause good balance when sitting, standing and walking (Vuong et al., 2018). According to another study, 16 elderly people were randomly given core exercise for 4 weeks compared to the control group who were not given exercise, the results were able to improve dynamic balance in lanisa, a good Center of Gravity (COG) made it easier for the elderly to return the body to a balanced position (Haruyama et al., 2017). In a study of 70 elderly people, the results obtained core exercise can increase the strength of the back muscles and leg muscles which have an impact on improving dynamic balance in the elderly (Jamini & Suwarno, 2018). Not only that, research on core stability exercise on 80 randomized respondents who were divided into intervention groups and control groups, in the intervention group the results obtained a significant increase in the dynamic balance of the elderly when sitting and walking (Cabanas-Valdés et al., 2016).

The Effect of Core Exercise on Frailty Level

The results of the analysis on the variable level of frailty before and after being given core exercise in the intervention group showed significant improvement with $P < 0.05$ which showed that there was a decrease in the level of frailty in the elderly through the measurement of the Fraity Index with an average pre-post test value of 1.55 and 0.6. Researchers assume that the decrease in frailty levels is due to the core exercise intervention provided. Core exercise provides more emphasis on leg muscles by combining 3 classifications of muscle exercises. The classification of muscle exercises involved is isotonic, which is an exercise that occurs due to shortening of muscle length, in this model of training the muscle tone tension does not change and only shortens due to training that prioritizes active movement in the joints and muscles get little pressure. The second classification of muscle training is isometric, in this exercise muscle shortening occurs but utilizes an increase in tension in the muscle and the third is isokinetic which utilizes maximum tension to trigger muscle contraction speed (Clifford et al., 2019).

Core exercise is able to increase back muscle strength and improve postural shape, this is due to core exercise in the form of isokinetic exercises that can improve postural structure and increase tension in the back muscles (Toprak Çelenay & Özer Kaya, 2017). Research shows that exercises that can increase back muscle strength can prevent the elderly from changes in postural shape caused by muscle contraction and changes in skeletal shape. stated that randomly 30 elderly people were given core exercise for 4 weeks compared to the control group who were not given exercise, the results were able to increase back muscle strength, endurance, and postural improvement in the intervention group (Jamini & Suwarno, 2018).

Core exercise not only increases back muscle strength, but can also increase pelvic and leg muscle strength, because the exercises applied not only train postural but also can train functional lower extremities. Back and leg muscles work synergistically to balance the body when sitting, standing and walking. Elderly people with strong leg muscles will easily stand without having to hold their knees and the floor, and with strong back muscles they will easily lift parts of the body from the pelvis up and can maintain balance when walking without holding a wall or stick. Research shows core exercises can restore functionality, balance when standing and increase mobility in the elderly. The increased activation of core exercise will result in an increase in the strength and endurance of the back and leg muscles that work synergistically to maintain balance in the elderly (Bagiartana & Huriah, 2023). Research shows muscle strength and physical performance are significantly related to the level of frailty in the elderly (Angulo et al., 2020).

Effect of Balance Strategy Exercise on Walking Speed

The results of the analysis on the variable level of walking speed before and after being given balance strategy exercise showed a significant increase with $P < 0.05$ which indicates

that there is an increase in walking speed in the elderly through 4MGST measurements with an average pre-post test value of 1.03 m/s - 1.14 m/s. In accordance with research on Balance Strategy Exercise can significantly improve postural balance in the elderly. Through the mechanism of action resulting from balance strategy exercise which is routinely carried out with a frequency of 3 times a week for 4 consecutive weeks can trigger the onset of effects in the form of neuromuscular adaptation. This is in line with other studies which state that through balance strategy exercise training can provide the effect of neuromuscular adaptation with the working principle in the form of an increase in the number of motor units that contract together, it will stimulate an increase in muscle strength (Murtiyani et al., 2019).

This is also supported by research that by doing the three strategies of this exercise in the form of ankle, hip, and stepping strategy exercise can improve postural balance and be able to improve the length of the elderly steps in one gait cycle (stride length) and shorten the time in stepping, so that postural balance in the elderly can be achieved (Aras et al., 2018). Balance strategy exercise will also activate neuromuscular adaptations that trigger an increase in muscle strength through increasing the number of motor units in muscle contractions. This result is also supported by the formation of proprioceptor optimization that delivers motor signals, so that joints and muscles can be stimulated directly, which then results in postural balancing reactions (Lazdia et al., 2018).

Effect of Balance Strategy Exercise on Frailty Level

The results of the analysis on the frailty level variable before and after being given a balance strategy exercise showed a decrease with P <0.05 with a mean pre-post test value (1.6 - 1.4) which means that there is a decrease in the level of frailty in the elderly through the measurement of the Frailty Index. Balance strategy exercise has been shown to be effective in increasing lower limb muscle strength by involving muscle contractions that are carried out regularly through this exercise (Aras et al., 2018). Increased muscle strength in the lower limbs and optimization of postural balance is obtained through the mechanism of balance strategy exercise supported by muscle activation in the stages of this exercise strategy in the form of ankle, hip, stepping strategy exercise with the delivery of motor signals carried by sensory information through mechanoreceptors regarding changes in body position sensation until it is forwarded to the anterior motor neurons and produces action potentials that are useful for muscle contraction. The activated muscles will be responsible for postural control as well as supporting the limit of stability, so that postural balance can be created optimally. In addition, the balance strategy exercise will optimize the utilization of the body's sensory response to postural balance in the elderly, so that not only the motor response but also involves sensory and neurological responses (Lazdia et al., 2018).

One aspect that causes frailty in the elderly is the risk of falling.72 This study is in line with previous research that in balance strategy exercise the neuromuscular function of the ankle joint plays an important role which will send body position information through the nervous system which causes postural changes so that the body's perception of safe postural control occurs. Balance strategy exercise not only increases leg muscle strength but also increases proprioceptive sensitivity (Park et al., 2016). Research shows balance strategy exercise reduces the risk of falling by 13% to 24% in the elderly with frailty (Nur'amalia et al., 2022).

Differences Effects of Core Exercise and Balance Strategy Exercise on Increased Walking Speed and Frailty Level in Elderly

Based on the results of statistical tests on walking speed between core and balance groups with 4MGST measurement parameters, the P> 0.05 value is obtained, which indicates that there is no significant difference between the two groups. While in the measurement parameter of the Frailty Index, the value of P < 0.05 is obtained, which shows the results of the comparison

between core exercise and balance strategy exercise show a significant difference in reducing the level of frailty of the elderly.

No previous studies have compared the effects of core exercise with balance strategy exercise on walking speed and frailty level in the elderly. However, based on the statistical analysis of the effect test in this study and supported by several theoretical studies by previous studies that discuss the effect of each of the two exercises, it explains that both core exercise and balance strategy exercise have an effect on walking speed and frailty level in the elderly. Measuring the level of difference in the effectiveness of these two exercise techniques based on statistical analysis obtained the assumption that there is a significant difference between the two different training methods. Based on the results of the bivariate test by observing the mean value and standard deviation of the pre-post test difference on both measurement parameters, namely, 4 Meter Gait Speed Test, and Frailty index shows core exercise has a higher effectiveness than balance strategy exercise on the level of frailty in the elderly.

CONCLUSION

This study generally proves that giving core exercise and balance strategy exercise has an effect in increasing walking speed and frailty levels in the elderly. There is no significant difference between Core exercise and Balance strategy exercise in increasing walking speed. However, there is a significant difference where Core exercise is better at reducing the level of frailty than balance strategy exercise in the elderly.

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REFERENCES

Angulo, J., El Assar, M., Álvarez-Bustos, A., & Rodríguez-Mañas, L. (2020). *Physical activity and exercise: Strategies to manage frailty*. *Redox Biology*, *35*, 101513. https://doi.org/10.1016/j.redox.2020.101513

Aras, D., Tammasse, J., & Syaiful, M. (2018). *The Effect of Sensomotoric Integration Exercise on Balance Disorder of Post Stroke Patients*. *International Journal of Sciences: Basic and Applied Research*, *42*(4), 124–130. http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Bagiartana, K. D. A., & Huriah, T. (2023). *The Effects of Core Stability Exercise in Improving Back Muscle Strength, Limb Muscles and Dynamic Balance in the Elderly in* Singaraja, Indonesia. *Jurnal Keperawatan Soedirman*, *18*(2), 58. https://doi.org/10.20884/1.jks.2023.18.2.6682

Cabanas-Valdés, R., Bagur-Calafat, C., Girabent-Farrés, M., Caballero-Gómez, F. M., Hernández-Valiño, M., & Urrútia Cuchí, G. (2016). *The effect of additional core stability exercises on improving dynamic sitting balance and trunk control for subacute stroke patients: a randomized controlled trial*. *Clinical Rehabilitation*, *30*(10), 1024–1033. https://doi.org/10.1177/0269215515609414

Clifford, C., Paul, L., Syme, G., & Millar, N. L. (2019). *Isometric versus isotonic exercise for greater trochanteric pain syndrome: a randomised controlled pilot study*. *BMJ Open Sport & Exercise Medicine*, *5*(1), e000558. https://doi.org/10.1136/bmjsem-2019-000558

Espejo-Antúnez, L., Pérez-Mármol, J. M., Cardero-Durán, M. de los Á., Toledo-Marhuenda, J. V., & Albornoz-Cabello, M. (2020). *The Effect of Proprioceptive Exercises on Balance and Physical Function in Institutionalized Older Adults: A Randomized Controlled Trial*. *Archives of Physical Medicine and Rehabilitation*, *101*(10), 1780–1788. https://doi.org/10.1016/j.apmr.2020.06.010

Fatimah S, S., Winaya, I. M. N., & Artini, I. G. A. (2022). Core Exercise Sama Baiknya dengan Balance Exercise Dalam Meningkatkan Keseimbangan Dinamis Pemain Futsal. *Media Kesehatan Politeknik Kesehatan Makassar*, *17*(2), 296. https://doi.org/10.32382/medkes.v17i2.2817

Haruyama, K., Kawakami, M., & Otsuka, T. (2017). *Effect of Core Stability Training on Trunk Function, Standing Balance, and Mobility in Stroke Patients*. *Neurorehabilitation and Neural Repair*, *31*(3), 240–249. https://doi.org/10.1177/1545968316675431

Hikmah, L., & Pradana, A. A. (2022). Faktor yang Mempengaruhi Kondisi Frailty pada Lanjut Usia. *Jurnal Penelitian Kesehatan Suara Forikes*, *13*(3), 624–629.

Jamini, T., & Suwarno, M. L. (2018). Pengaruh *Trunk Stability Exercise* Terhadap Kekuatan Otot Punggung dan Otot Tungkai Pada Lanjut Usia Di PSTW Budi Mulia I dan II Jakarta Timur. *Jurnal Keperawatan Suaka Insan (JKSI)*, *3*(1), 1–9.

Kamaledin ---Mousavi, S., & Sadeghi, H. (2013). *Functional Comparison between Kinematic Parameters in Voluntary and Involuntary Gait Initiation in Active Male*. http://journals.tums.ac.ir/

Khaerah, D. M. (2021). Perbedaan Efek Antara *Balance Strategy Exercise* Dengan Gaze Stability Exercise Terhadap Peningkatan Keseimbangan Postural Pada Lansia. Universitas Hasanuddin.

Lazdia, W., Amelia, S., & Silviani, S. (2018). *Balance Exercise To Postural Balance In Elderly At* Ptsw Kasih Sayang Ibu, Batusangkar. *Indonesian Nursing Journal Of Education And Clinic (INJEC)*, *1*(2), 117. https://doi.org/10.24990/injec.v1i2.63

McCormick, R., & Vasilaki, A. (2018). *Age-related changes in skeletal muscle: changes to life-style as a therapy*. *Biogerontology*, *19*(6), 519–536. https://doi.org/10.1007/s10522-018-9775-3

Mehrlatifan, S., Fatahi, A., & Khezri, D. (2023). *Biomechanics of Gait in the Elderly: A Literature Review*. *Asian Journal of Sports Medicine*, *14*(2). https://doi.org/10.5812/asjsm-135663

Melinda, D. (2019). *Hubungan indeks masa tubuh dengan postur kaki menggunakan foot posture index (FPI) pada mahasiswa pendidikan dokter Universitas Sriwijaya angkatan 2016*. Universitas Sriwijaya.

Murtiyani, N., Suidah, H., Program,), Keperawatan, S., Keperawatan, A., Mojokerto, D. H., Korespondensi, A., Raya, J., No, G., 77, K., Sooko, K., Mojokerto, J., & Timur, I. (2019). Pengaruh Pemberian Intervensi 12 *Balance Exercise* Terhadap Keseimbangan Postural Pada Lansia. In *Jurnal Keperawatan* (Vol. 12, Issue 1).

Nur'amalia, R., Mutmainnah, M., Lestari, A. I., & Sulastri, S. (2022). *Effect of Balanced Exercise and Ankle Strategy Exercise on the Risk of Falling in the Elderly*. *Jurnal Ilmiah Kesehatan Sandi Husada*, 424–430. https://doi.org/10.35816/jiskh.v11i2.803

O'Caoimh, R., Sezgin, D., O'Donovan, M. R., Molloy, D. W., Clegg, A., Rockwood, K., & Liew, A. (2021). *Prevalence of frailty in 62 countries across the world: a systematic review and meta-analysis of population-level studies*. *Age and Ageing*, *50*(1), 96–104. https://doi.org/10.1093/ageing/afaa219

Papalia, G. F., Papalia, R., Diaz Balzani, L. A., Torre, G., Zampogna, B., Vasta, S., Fossati, C., Alifano, A. M., & Denaro, V. (2020). *The Effects of Physical Exercise on Balance and Prevention of Falls in Older People: A Systematic Review and Meta-Analysis*. *Journal of Clinical Medicine*, *9*(8), 2595. https://doi.org/10.3390/jcm9082595

Park, K.-H., Lim, J.-Y., & Kim, T.-H. (2016). *The effects of ankle strategy exercises on unstable surfaces on dynamic balance and changes in the* COP. *Journal of Physical Therapy Science*, *28*(2), 456–459. https://doi.org/10.1589/jpts.28.456

Pradana, A. A., Chiu, H. L., Lin, C. J., & Lee, S. C. (2023). *Prevalence of frailty in Indonesia: a systematic review and meta-analysis*. *BMC Geriatrics*, *23*(1). https://doi.org/10.1186/s12877-023-04468-y

Redha, A. H., Adnindya, M. R., Septadina, I. S., Suciati, T., & Wardiansah, W. (2022). Analisis Hubungan Usia, Indeks Masa Tubuh, Kecepatan Berjalan Dan Riwayat Jatuh Dengan Keseimbangan Berjalan Lansia Majelis Taklim Asmaul Husna Palembang. *Jurnal Kedokteran Dan Kesehatan : Publikasi Ilmiah Fakultas Kedokteran Universitas Sriwijaya*, *9*(2), 191–198. https://doi.org/10.32539/JKK.V9I2.17491

Sadaqa, M., Németh, Z., Makai, A., Prémusz, V., & Hock, M. (2023). *Effectiveness of exercise interventions on fall prevention in ambulatory community-dwelling older adults: a systematic review with narrative synthesis*. *Frontiers in Public Health*, *11*. https://doi.org/10.3389/fpubh.2023.1209319

Shah, D. N., & Varghese, A. (2014). *Effect of Core Stability Training on Dynamic Balance in Healthy Young Adults - A Randomized Controlled Trial*. *International Journal of Physiotherapy*, *1*(4), 187. https://doi.org/10.15621/ijphy/2014/v1i4/54563

Siallagan, D., & Gessal, J. (2021). *Geriatric Frailty Syndrome . Jurnal Medik Dan Rehabilitasi (JMR)*, *3*(1).

Sulfitra, S., Idris, I., & Aras, D. (2022). *The Difference between Square Step Exercise and Balance Strategy Exercise Effects On The Change of Limb Muscle Strength and Balance in Elderly People*. *Competitor: Jurnal Pendidikan Kepelatihan Olahraga*, *14*(2), 170. https://doi.org/10.26858/cjpko.v14i2.35427

Suryamin. (2015). *Statistical Yearbook of* Indonesia. *In Badan Pusat Statistik* (pp. 592–598).

Toprak Çelenay, Ş., & Özer Kaya, D. (2017). *An 8-week thoracic spine stabilization exercise program improves postural back pain, spine alignment, postural sway, and core endurance in university students:a randomized controlled study*. *Turkish Journal Of Medical Sciences*, *47*, 504–513. https://doi.org/10.3906/sag-1511-155

Undang Undang Republik Indonesia Nomor 13 Tahun 1998 Tentang Kesejahteraan Lanjut Usia (1998).

Vuong, K., Canning, C. G., Menant, J. C., & Loy, C. T. (2018). *Gait, balance, and falls in Huntington disease* (pp. 251–260). https://doi.org/10.1016/B978-0-444-63916-5.00016-1

WHO. (2020). *UN Decade of Healthy Ageing: Plan of Action*.

Wibawa, A., Juhanna IV, Dewi, A. A. N. T. N., & Saraswati, P. A. S. (2017). *Manajemen Fisioterapi Geriatri*. 1–29.